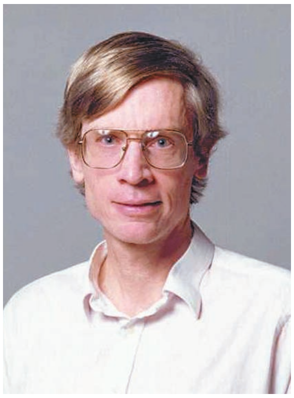
CANADIANS IN PHYSICS

Follow Your Dreams

One of the great honours in physics is to have a physical law or constant named after you — Newton's laws, Planck's constant, the Heisenberg uncertainty principle. Now, the name of Canadian physicist Dr. Ian Keith Affleck can be added to this list. "Affleck-Dine Baryogenesis" is the name given to a physical mechanism that might have played an important role in the early universe in creating one of the classes of particles that now make up all of the matter that exists today.

For Dr. Affleck, who was born in Vancouver and grew up both there and in Ottawa, understanding nature has always been one of his great interests. "I became rather fascinated at a fairly young age with the idea that deep things about the universe could be understood by using mathematics," he explains. At high school in Ottawa, he was inspired by the intellectual enthusiasm of his physics teachers, and in university decided on a career in theoretical physics. Ironically, at the time, he "was not very optimistic about actually being able to make a career from my interests."



Dr. Ian Affleck

One of the great questions plaguing theoretical physicists is nothing less than the age-old philosophical question: Why are we here? It is believed that at the time of the Big Bang, there were nearly equal amounts of matter and antimatter. Since matter and antimatter annihilate each other, if the amounts of each were *exactly* equal, there would be nothing left after particle annihilation. So, there had to be some excess of matter over antimatter, and it had to be just the right amount of excess to yield the universe and the physics that exist today. Dr. Affleck, together with fellow theoretician Michael Dine, proposed a possible explanation — Affleck-Dine Baryogenesis. Verifying this principle is now an active part of physics research all over the world.

Dr. Affleck has since gone on to bring his mathematical talents to more immediate problems. Specifically, he has been hard at work adapting the mathematics he helped develop for an understanding of the universe to problems of understanding how and why high-temperature superconductors work. "I saw some opportunities to apply the same sort of mathematical ideas more directly," he says. Just as there is a problem with the pairing of particles and antiparticles in the early universe, there appears to be a pairing mechanism at work in the behaviour of high-temperature superconductors, so that it is possible to gain a deeper understanding of these materials through mathematics originally devised for more abstract research.

Such creative thinking has earned the physicist a number of awards, including the Rutherford Medal and the Governor General's Medal. He is also the recipient of many honorary degrees. His advice to aspiring physicists is simple: "They should follow up on what they find interesting, and not be afraid to follow their dreams."

Going Further

1. The astronomer Carl Sagan used to say, "You never know where inspiration will come from." One of Dr. Affleck's great achievements was to adapt what seemed like very abstract and very specific physical theory to a more concrete problem. This is not the first time this has happened in the history of physics; look into a few of the popular books on physics and see if you can find some other examples. (Hint: You can start with Carl Sagan.)
2. Much of Dr. Affleck's recent work has had to do with superconductivity. Superconductors have applications in medicine, engineering, and elsewhere. Research two different present-day applications related to superconductivity.
3. What are some of the difficulties with the superconductors now in use? Report and discuss with the class. Design a poster or a media presentation to present your findings.

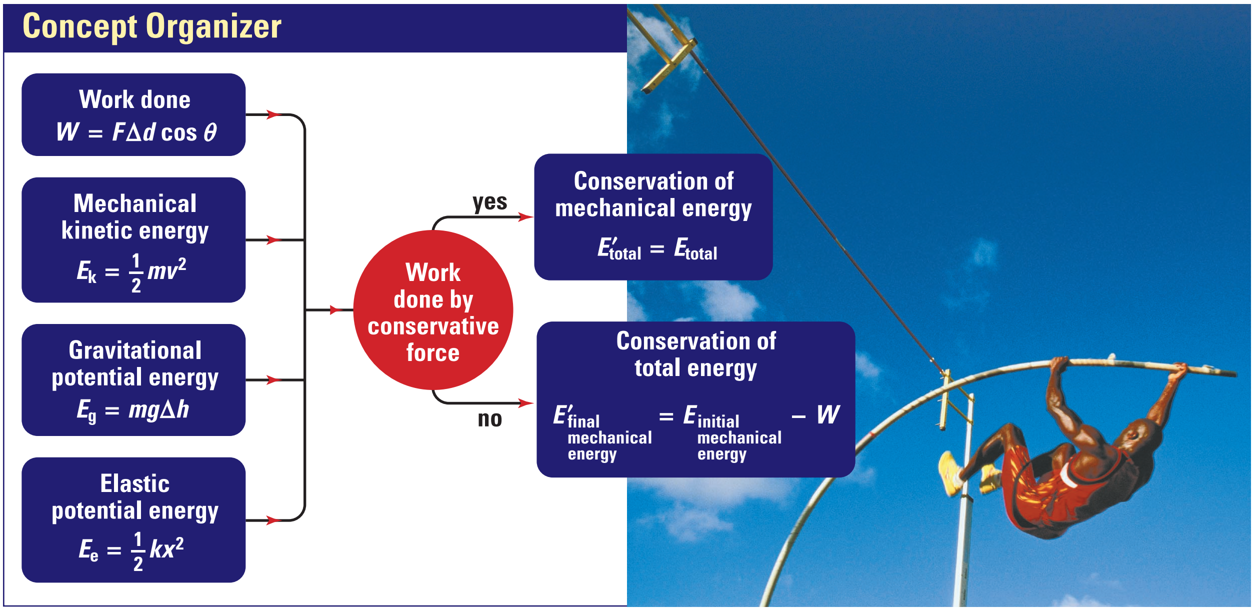


Figure 5.17 How many energy transformations are taking place in the photograph?

5.3 Section Review

1. K/U
   (a) Why is the application of the law of conservation of energy often much easier than the application of the law of conservation of momentum?
   (b) What conditions can increase the difficulty of applying the law of conservation of energy?

2. K/U Which types of energy are generally referred to as mechanical energy?

3. C Using examples not found in the textbook, describe and explain an example in which the forces are
   (a) conservative
   (b) non-conservative

4. I A student is sliding down a frictionless water slide at an amusement park.
   (a) Sketch a graph of gravitational potential energy against height for the descent. (No numbers are required on the axes.)
   (b) On the same axes, sketch a graph of the total energy of the student against height for the descent.
   (c) On the same axes, sketch a graph of the kinetic energy of the student against height for the descent.

5. MC
   (a) In an amusement park there is a ride on which children sit in a simulated log while it slides rapidly down a water-covered slope. At the bottom, the log slams into a trough of water, which slows it down. Why did the ride designers not simply have the log slam into a large spring?
   (b) Steel or plastic barrels are located along highways to cushion the impact if a car skids into a bridge abutment. These barrels are often filled with energy-absorbing material. Why are these barrels used instead of large springs to bring the cars to a stop?